Notice No.4

Rules and Regulations for the Classification of Naval Ships, January 2016

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Issue date: December 2016

Amendments to	Effective date	Mandatory Instrument
Volume 2, Part 1, Chapter 3, Sections 3, 4 & 5	1 January 2017	
Volume 2, Part 2, Chapter 1, Sections 2 & 3	1 January 2017	
Volume 2, Part 3, Chapter 2, Section 4	1 January 2017	
Volume 2, Part 3, Chapter 2, Sections 3 & 6	1 January 2017	X
Volume 2, Part 4, Chapter 1, Section 5	1 January 2017	
Volume 2, Part 4, Chapter 4, Sections 7 & 8	1 January 2017	
Volume 2, Part 4, Chapter 5, Section 4	1 January 2017	
Volume 2, Part 5, Chapter 1, Section 2	1 January 2017	
Volume 2, Part 5, Chapter 1, Section 3	1 January 2017	X
Volume 2, Part 7, Chapter 1, Sections 2 & 4	1 January 2017	
Volume 2, Part 7, Chapter 1, Section 5	1 January 2017	X
Volume 2, Part 7, Chapter 2, Section 10	1 January 2017	X
Volume 2, Part 9, Chapter 1, Sections 1, 2 & 4	1 January 2017	
Volume 2, Part 9, Chapter 2, Section 7	1 January 2017	
Volume 2, Part 9, Chapter 3, Sections 6, 7 & 8	1 January 2017	
Volume 2, Part 9, Chapter 4, Section 4	1 January 2017	
Volume 2, Part 9, Chapter 5, Section 4	1 January 2017	
Volume 2, Part 9, Chapter 6, Section 4	1 January 2017	
Volume 2, Part 9, Chapter 11, Section 1	1 January 2017	
Volume 2, Part 11, Chapter 1, Section 3	1 January 2017	

Volume 2, Part 1, Chapter 3
Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

■ *Section 3*
Documentation required for design review

3.3 Calculations and specifications

3.3.12 **Electromagnetic compatibility (EMC)** *See also Vol 2, Ch 3, 4.13 Electromagnetic compatibility (EMC)*. ~~A test plan in accordance with Clause 5 of IEC 60533 for electromagnetic compatibility is to be submitted for information.~~ ~~*See Vol 2, Pt 1, Ch 3.13 Electromagnetic compatibility (EMC)*~~ ~~for EMC requirements.~~

(a) The following set of EMC documents is to be submitted and is to include, but not be limited to:

(i) an EMC Management Plan which details the ships operational role and defines the EM (Electromagnetic) environment, requirements and responsibilities;

(ii) an EMC Control Plan, which defines the design and mitigation measures to be taken to achieve EMC in the agreed EM threat environment. These are to include, but are not limited to the following:

- the EM threats, *see Vol 2, Pt 1, Ch 3, 3.3 Calculations and specifications 3.3.12(b)* below;
- the zoning concept used;
- a declaration of the emission levels;
- a declaration the minimum immunity levels;
- shielding techniques and requirements;
- cabling requirements; and
- filtering requirements.

(iii) an EMC Implementation Plan, which defines the techniques to be used to mitigate the Electromagnetic (EM) threats and the requirements of the EMC Control Plan, including the installation techniques to be applied, *see Vol 2, Pt 1, Ch 3, 4.13 Electromagnetic compatibility (EMC) 4.13.3*; and

(iv) an EMC Test Plan, which defines the verification and validation requirements, which are to include the analysis, inspection, demonstration and testing requirements, *see Vol 2, Pt 1, Ch 3, 4.13 Electromagnetic compatibility (EMC) 4.13.2*.

NOTE Based on the submissions required above, LR will conduct appropriate inspections to verify the processes and techniques defined have been applied correctly.

(b) the EM Threats are to be defined using the most appropriate method for the assigned ship type and vessel ConOps, *See Vol 1, Pt 1, Ch 2 Requirements for Machinery and Engineering Systems of Unconventional Design*, and one of the following methods:

- applying the requirements and guidelines of IEC 60533, *Electrical Installations in Ships, Electromagnetic Compatibility*; or
- applying Naval Authority requirements, as defined in an appropriate naval standard acceptable to LR; or
- conducting an EM threat assessment which, so far as is reasonably practicable:
  - o identifies all the EM threats and associated hazards;
  - o identifies all the process, procedures and mitigation requirements which are to be applied to achieve the required EMC in the EM threat environment; and
  - o has been agreed between shipbuilder and Naval Authority, and is acceptable to LR.

(c) The ship design must be demonstrated to have taken adequate measures to ensure the required performance of Ship Type and Mobility systems are maintained under all normal and reasonably foreseeable abnormal conditions, *see Vol 2, Pt 1, Ch 3,14.3 Electromagnetic compatibility (EMC)*.

■ *Section 4*
Operating conditions

4.13 Electromagnetic compatibility (EMC)

4.13.1 For documentation required for design review *See also Vol 2, Ch 3, 3.12 Electromagnetic compatibility (EMC)*.

~~4.13.1~~ 4.13.2 ~~Propulsion, steering, navigation and other~~ Mobility and/or Ship Type systems, including weapons systems, are to be designed and installed such that their performance does not degrade from the manufacturer's specifications as a result of susceptibility to electromagnetic interference (EMI). This is to apply to EMI generated during both normal ship operations and during military activities.

~~4.13.2~~ 4.13.3 ~~An EMC test plan is to be established, an EMC analysis carried out and a test report produced in accordance with the requirements and guidelines of IEC 60533~~ ~~*Electrical Installations in Ships, Electromagnetic Compatibility*~~ ~~or equivalent requirements of the Naval Administration as defined in a specified standard. Regard is to be given to the fact that EMC requirements for systems installed on board naval ships may be more onerous due to the high concentration of electronic equipment, transmitters and receivers located in close proximity. Details are to be submitted for appraisal.~~

An EMC Test Plan is to be established, an EMC analysis carried out and a test report produced, which are to be submitted for review. These are to be in accordance with one of the following:

(a) the requirements and guidelines of IEC 60533, *Electrical Installations in Ships, Electromagnetic Compatibility;* or

(b) the requirements of the Naval Authority, equivalent to (a), as defined in an appropriate naval standard; or
(c) the requirements of the EMC Management Plan for the ship application, according to its defined EM environment.

~~4.13.3~~ 4.13.4 ~~Systems are to comply with the emission limits and minimum immunity requirements of the specified standards. This may require systems complying with emissions and immunity requirements of IEC 60533 *Electrical Installations in Ships, Electromagnetic Compatibility* to be subjected to additional testing in order to demonstrate the requirements of the specified standards are satisfied unless the EMC analysis clearly identifies such testing to be unnecessary. Details are to be submitted for appraisal.~~
The EMC Test Plan is to demonstrate that an assessment of the verification and validation requirements has been made, which demonstrates that the appropriate EMC requirements have been specified.

4.13.5 The assessment required by paragraph *Vol 2, Pt 1, Ch 3, 4.13 Electromagnetic compatibility (EMC) 4.13.3* is to consider:
(a) the relative proximity and quantity of electrical and electronic equipment to each other, such as transmitters and receivers; and
(b) whether the EMC requirements proposed are adequate, or whether more onerous requirements are needed.

4.13.6 Mobility, Ship Type and Ancillary systems are to comply with the appropriate emission and minimum immunity levels defined in one of the following, and as appropriate to the assigned ship and vessel ConOps, *see Vol 2, Pt 1, Ch 2 Requirements for Machinery and Engineering Systems of Unconventional Design*;
(a) IEC 60533, *Electrical Installations in Ships, Electromagnetic Compatibility.* Additional testing is to be conducted when the EMC analysis does not clearly identify that the requirements of the Naval Authority are satisfied; or
(b) an appropriate naval standard, acceptable to the Naval Authority; or
(c) an EMC Control Plan (*see Vol 2, Pt 1, Ch 3, 3.3 Calculations and specifications 3.3.12*).

■ *Section 5* **Machinery space arrangements**

5.5 Resilient ~~mountings~~ mount

5.5.1 The dynamic angles of inclination in *Table 3.4.2 Inclinations* may be exceeded in certain circumstances dependent upon ship type and operation. The Shipbuilder is, therefore, to ensure that the vibration levels of flexible pipe connections, shaft couplings and mounts remain within the limits specified by the component manufacturer for the following conditions ~~of maximum dynamic inclinations to be expected during service, start-stop operation and the natural frequencies of the system. Due account is to be taken of any creep that may be inherent in the mount.~~:
(a) Maximum dynamic inclinations to be expected during service;
(b) Start-stop operation; and
(c) The natural frequencies of the system.
Due account is to be taken of any creep that may be inherent in the mount.

5.5.2 For equipment of installed power greater than 375 kW, *see Vol 2, Pt 1,Ch 3, 5.1 Machinery spaces, 5.1.1*, a calculation report is to be submitted to demonstrate that the requirements of *Vol 2, Pt 1, Ch 3, 5.5 Resilient mount 5.5.1* are met. The calculation report is to include as a minimum:
(a) A plan showing the arrangement of the machinery including mounts, exhaust bellows, and flexible couplings and pipe connections, as applicable; and
(b) Maximum allowable loads and deflections and any appropriate type approval documentation for each flexible element (resilient mounts, exhaust gas bellows, flexible couplings and any other applicable flexible pipe connections) for the conditions identified in *Vol 2, Pt 1, Ch 3, 5.5 Resilient mount 5.5.1*; and
(c) Calculations including natural frequencies and maximum expected loads and deflections of each flexible element (resilient mounts, exhaust gas bellows, flexible couplings and any other applicable flexible pipe connections) for the conditions identified in *Vol 2, Pt 1, Ch 3, 5.5 Resilient mount 5.5.1*.

~~5.5.2~~ 5.5.3 ~~Limit stops are to be fitted as necessary~~ Positive means are to be fitted to ensure that manufacturers' limits for lateral or vertical motion are not exceeded. Where resilient mounts are approved for collision loading, then the extent of any additional anti-collision chocking that may be required will be specially considered. Suitable means are to be provided to accommodate the propeller thrust.

~~5.5.3~~ 5.5.4 Mounts are to be shielded from the possible detrimental effects of oil and, where appropriate, paint and other contaminants.

5.5.5 Shafting, piping connections and electrical cable connections are to be provided with sufficient flexibility to accommodate expected movements. Particular attention should be paid to exhaust bellows and the effectiveness of flexible couplings.

5.6 Additional requirements for resilient mounts

5.6.1 Where the ship has specified military requirements that include the ability of machinery to withstand shock, the flexible element(s) (resilient mounts, exhaust gas bellows, flexible couplings and any other applicable flexible pipe connections) are to be approved in accordance with such requirements. *See also Vol 1, Pt 1, Ch 2, 3.8 Military Distinction notations*, *Vol 1, Pt 4, Ch 2, 5.7 Shock mounts* and *Vol 2, Pt 1, Ch 3, 4.11 Machinery shock arrangements*.

5.6.2 Where the ship has specified military requirements for underwater signature, the flexible element(s) (resilient mounts, exhaust gas bellows, flexible couplings and any other applicable flexible pipe connections) are to be approved in accordance with such requirements. *See also Vol 2, Pt 1, Ch 3, 4.10 Guidance for underwater signature*.

~~5.6~~ 5.7 Resin chocks

~~5.6.1~~ 5.7.1 Synthetic resin compounds used as materials for chocks under machinery components ~~where~~ for which alignment is ~~important~~ critical, e.g. main engine, gearbox and auxiliary installations where the engine and generator do not share a common baseplate, are to be of a type accepted by LR.

5.7.2 The resin chock materials referred to in *Vol 2, Pt 1, Ch 3, 5.4 Collision load 5.4.1* are to be tested in accordance with *Ch 14, 2.11 Machinery chocking compounds (resin chocks), Ch 14, 3.9 Machinery chocking compounds and Ch 14, 5.14 Synthetic chocking compounds* of the *Rules for the Manufacture, Testing and Certification of Materials.*

~~5.6.3~~ 5.7.3 Materials for ~~chocking~~ chockings are to be approved for the maximum ~~ambient operating temperature of the space in which they are installed~~ service temperature that the chock will experience.

~~5.6.2~~ 5.7.4 The use of resin for chocking gas turbine casings or similar high temperature applications ~~is not acceptable~~ will be specially considered.

5.8 Additional requirements resin chocks

~~5.6.4~~ 5.8.1 Where the ship has specified military requirements that include design and installation of machinery to withstand shock, the resin is to be approved for this application. *See also Vol 1, Pt 1, Ch 2, 3.8 Military Distinction notations*, *Vol 1, Pt 4, Ch 2, 5.6 Seat design* and *Vol 2, Pt 1, Ch 3, 4.11 Machinery shock arrangements*.

Sub-sections 5.7 *to* 5.14 *have been renumbered* 5.9 *to* 5.16*.*

Volume 2, Part 2, Chapter 1
Reciprocating Internal Combustion Engines

■ *Section 2*
Documents required for design review

2.2 Submission requirements

2.2.7 Where engine components are subject to autofrettage, the following information is to be submitted (*see also Vol 2, Pt 2, Ch 1, 3.5 Autofrettage*):

(a) Drawings and other related documents/information for products to be subjected to autofrettage, including material grade and dimensions.
(b) Details of product quality assurance processes.
(c) Place of manufacture and details of external providers of products subjected to autofrettage.
(d) A report detailing how repeatability and reliability of the autofrettage process is achieved. This is to include the following:
    (i) method of autofrettage;
    (ii) method to control extent of autofrettage;
    (iii) calibration of the autofrettage system; and
    (iv) details of how the critical parameters affecting product characteristics are controlled.
(e) Method for recording results and list of data that is recorded.
(f) Finished component and/or system testing.

■ *Section 3*
Materials and components

3.1 Crankshaft materials

(*Part only shown*)

Table 1.3.1 Test and certification requirements for engine components

Part	Materials Tests				Component Tests		LR Component Certification
	Material Properties *see* Note 1	Surface Inspection *see* Note 2	Ultrasonic Inspection	LR Material Certification *see* Note 3	Hydraulic testing *see* Note 5	Visual inspection	
					(All Engines)		
High pressure fuel injection system - valve, pipe, pump body (pressure side) (9, 10)	All	-	-	a	Lesser of 1,5p or p + 300 bar *see* Note 9	V	X
Note 9. Where components are subjected to an autofrettage process ~~approved~~ accepted by LR *(see Vol 2, Pt 2, Ch 1, 3.5 Autofrettage)*, the component pressure test may be omitted. The assembled system containing such components is to be shown, where practicable, to be pressure-tight as required for hydraulic systems.							

3.5 Autofrettage

3.5.1 Manufacturers, and external providers of products or services, who carry out autofrettage of engine components, ~~to enhance the fatigue life of components~~ are to ~~be~~ apply an approach for product assurance that is ~~approved~~ accepted by LR.

3.5.2 ~~LR certificates are to be issued for components subject to autofrettage, provided the attending Surveyors are satisfied that the required process parameters and associated QA processes have been applied.~~ Documentation for the autofrettage process and the associated approach for product assurance is to be submitted in accordance with *Vol 2, Pt 2, Ch 1, 2.2 Submission requirements 2.2.7*.

3.5.3 Testing carried out as part of the approach for product assurance is to confirm that the autofrettage process has not detrimentally affected the components and demonstrate that the prescriptive Rule requirements for pressure containment have been met, *see Table 1.3.1 Test and certification requirements for engine components*.

Volume 2, Part 3, Chapter 2
Shafting Systems

■ *Section 3*
Materials

3.1 Materials for shafts

3.1.5 Where materials with greater specified or actual tensile strengths than the limitations given above are used, reduced shaft dimensions or higher permissible vibration stresses are not acceptable when derived from the formulae used in *Vol 2, Pt 3, Ch 2, 4.2 Intermediate shafts, Vol 2, Pt 3, Ch 2, 4.4 Screwshafts and tube shafts* and *Vol 2, Pt 5, Ch 1, 3.2 Limiting stress in propulsion shafting* unless, for intermediate shafts only, it is verified that the materials exhibit a similar fatigue life to conventional steels through compliance with the requirements in *Vol 2*, *Pt 3, Ch 2, 6 Approval of alloy steel used for intermediate shaft material.*

■ *Section 4*
Design and construction

4.2 Intermediate shafts

4.2.6 The application of k = 1,20 is limited to shafts with longitudinal slots having a length of ~~not more~~ less than 0,8d_o and a width of ~~not more~~ greater than 0,15d_o and a diameter of central hole d_i of ~~not more~~ less than ~~0,8~~0,7d_o *see Vol 2, Pt 3, Ch 4.5 Hollow shafts*. The end rounding of the slot is not to be less than half the width. An edge rounding should preferably be avoided as this increases the stress concentration slightly. The values of ~~c~~C_K, *see Table 1.3.1* C_k *factors* in *Pt 5, Ch 1 Torsional Vibration*, are valid for 1, 2 and 3 slots, i.e. with slots at 360, 180 and 120 degrees apart respectively.

4.4 Screwshafts and tube shafts

4.4.3 The diameter, d_p of the protected forged steel screwshaft immediately forward of the forward face of the propeller boss or, if applicable, the forward face of the screwshaft flange, is to be not less than determined by the following formula:

$$d_p = 100k \sqrt[3]{\frac{P}{R}\left(\frac{560}{\sigma_u + 160}\right)} \quad mm$$

where

k = 1,22 for a shaft carrying a keyless propeller fitted on a taper, or where the propeller is attached to an integral flange, and where the shaft is fitted with a continuous liner, a coating of an approved type, or is oil lubricated and provided with an approved type of oil sealing gland

= 1,26 for a shaft carrying a keyed propeller and where the shaft is fitted with a continuous liner, a coating of an approved type, or is oil lubricated and provided with an approved type of oil sealing gland

P and *R* are as defined in *Vol 2, Pt 1, Ch 3, 4.3 Power ratings* (losses in gearboxes and bearings are to be disregarded)

σ_u = specified minimum tensile strength of the shaft material, in N/mm^2 but is not to be taken as greater than 600 N/mm^2 *see Vol 2, Pt 3, Ch 2, 3.1 Materials for shafts 3.1.4*.

4.8 ~~Flange connections of couplings~~ Couplings and transitions of diameters

4.8.4 All couplings which are attached to shafts are to be of approved dimensions.

Existing paragraphs 4.8.4 *to* 4.8.6 *have been renumbered* 4.8.5 *to* 4.8.7.

■ *Section 6*
Approval of alloy steel used for intermediate shaft material

6.1 Application

6.1.1 The requirements of *Section 6* are, in addition to the requirements of the *Rules for the Manufacture, Testing and Certification of Materials*, *Ch 5*, *3 Forgings for shafting and machinery*, to be applied to the approval of alloy steel which has a minimum specified tensile strength greater than 800 N/mm^2, but, not exceeding 950 N/mm^2 intended for use as intermediate shaft material.

6.2 Torsional fatigue test

6.2.1 A torsional fatigue test is to be performed to verify that the material exhibits a similar fatigue life to conventional steels. The torsional fatigue strength of the material is to be equal to or greater than the permissible torsional vibration stress τ_c given by the formulae in *Vol 2*, *Pt 5, Ch 1, 3.2 Limiting stress in propulsion shafting*.

6.2.2 The test is to be carried out with notched and unnotched specimens respectively. For calculation of the stress concentration factor of the notched specimen, fatigue strength reduction factor β should be evaluated in consideration of the severest torsional stress concentration factor in the design criteria.

6.2.3 Test procedures are to be in accordance with Section 10 of ISO 1352 and the test conditions applied are to be in accordance with *Table 2.6.1 Test Condition*. Mean surface roughness is to be less than 0,2μm Ra with the absence of localised machining marks verified by visual examination at low magnification (x20) as required by Section 8.4 of ISO 1352.

Table 2.6.1 Test Condition

Loading type	Torsion
Stress ratio	*R* = -1
Load waveform	Constant amplitude sinusoidal
Evaluation	S-N curve
Number of cycles for test termination	1 x 10^7

6.2.4 The measured torsional fatigue strength for continuous operation, τ_c, and torsional fatigue strength for transient operation, τ_t, are to be equal to or greater than the values given by the following formulae:

$$\tau_c \geq \frac{\sigma_u + 160}{6} . C_k . C_d \quad \text{for } r = 0$$

$$\tau_t \geq 1{,}7\, \tau_c \frac{1}{\sqrt{C_k}}$$

Where

C_k = a factor for different shaft design features, *see Table 1.3.1 C_k factors, Vol 2, Pt 5, Ch 1, 3.1 Symbols and definitions 3.1.4*

C_d = size factor, *see Vol 2, Pt 5, Ch 1, 3.1 Symbols and definitions, 3.1.1*

σ_u = specified minimum tensile strength of the shaft material, in N/mm^2

r = speed ratio, N/N$_s$, *see Vol 2, Pt 5, Ch 1, 3.1 Symbols and definitions, 3.1.1*

6.3 Material requirements

6.3.1 The steels are to have a degree of cleanliness as shown in *Table 2.6.2 Cleanliness requirements* when tested according to ISO 4967 method A. Representative samples are to be obtained from each heat of forged or rolled products.

Table 2.6.2 Cleanliness requirements

Inclusion group	Series	Limiting chart diagram index I
Type A	Fine	1
	Thick	1
Type B	Fine	1,5
	Thick	1
Type C	Fine	1
	Thick	1
Type D	Fine	1
	Thick	1
Type DS	-	1

Volume 2, Part 4, Chapter 1
Propellers

■ *Section 5*
Documentation required for design review

5.2 Plans

5.2.3 For blades of fixed pitch propellers with skew angle of 30 degrees or greater, the stresses in the propeller blade during astern operation are not to exceed 80 per cent of the propeller blade material proof stress. Consideration is to be given to failure conditions and a factor of safety of 1,5 is to be attained using an acceptable fatigue failure criteria. Documentary evidence confirming that these criteria are satisfied is to be submitted.

Existing paragraphs 5.2.3 *to* 5.2.6 *have been renumbered* 5.2.4 *to* 5.2.7.

Volume 2, Part 4, Chapter 4
Podded Propulsion Units

■ *Section 7*
Electrical equipment

7.1 General

7.1.5 Components, including but not limited to control equipment, sensors, slip rings, cable connections and auxiliary drives, are to withstand vibrations in accordance with IEC 60092-501, *Electrical installations in ships – Part 501, Special features – Electric propulsion plant*, or an alternative relevant International or National Standard or value specified by the Naval Authority.

7.2 Slip rings

7.2.3 Slip ring assemblies are to have a minimum ingress protection of IP23, according to IEC60529, *Degrees of protection provided by enclosures (IP Code)*.

7.2.4 Adequate provisions are to be taken to ensure that personnel are not endangered if an arc fault occurs, *see also Vol 2, Pt 9, Ch 4, 5 Protection from electric arc hazards within electrical equipment*.

7.2.5 Tests at the slip ring assembly manufacturers works are to include type and routine tests according to IEC 60092-501, *Electrical installations in ships – Part 501, Special features – Electric propulsion plant*.

■ *Section 8*
Control engineering ~~arrangements~~ systems

8.2 Monitoring and alarms

(Part only shown)

Table 4.8.1 Additional alarms and safeguards for podded propulsion units

Item	Alarm	Note
Bearing temperature	~~High~~ 1st stage high 2nd stage high	For grease lubricated bearings Actions to prevent damage to propulsion motor are to be instigated.
Lubricating oil temperature	~~High~~ 1st stage high 2nd stage high	*See also Vol 2, Pt 4, Ch 5, 4.5 Protection of propulsion system 4.5.9* Actions to prevent damage to propulsion motor are to be instigated.
Lubricating oil tank level for motor bearings	Low	Independent oil level inspection is required
Motor cooling air flow	Low	
Shaft bearing vibration monitoring	High	*See Vol 2, Pt 4, Ch 4, 6.3 Propulsion shafting 6.3.10.* Monitoring is to allow bearing condition to be gauged using trend analysis.

Volume 2, Part 4, Chapter 5
Electric propulsion

■ *Section 4*
Electric propulsion systems

4.1 General

4.1.3 The ventilation and cooling systems for electrical propulsion equipment are to be provided with monitoring devices arranged to operate an alarm if the temperature of the heated cooling medium exceeds a predetermined safe value. *See also Vol 2, Pt 9, Ch 3, 7.2 Semiconductor converters 7.2.5*.

4.4 Propulsion control

4.4.12 The factory acceptance test (FAT) of the propulsion control and power management system is to be carried out according to a FAT programme acceptable to LR. A reduced FAT programme for subsequent vessels in a series is subject to agreement by LR.

4.5 Harmonic filtering

4.5.1 The requirements in this Section are in addition to the requirements for harmonic filters in *Vol 2, Pt 9, Ch 4, 4.13 Harmonic filters*.

4.5.2 Where line filters are used to keep harmonic distortion within acceptable limits, the filter layout shall be designed for any conceivable line, generator and load combinations. *See also Vol 2, Pt 4, Ch 5, Section 4.3 Power requirements 4.3.9*.

4.5.3 In the event of filter circuit failure, continued safe operation of the propulsion system is to be possible by following appropriate procedures specified by the manufacturer and/or system integrator. These procedures are to include any operational limitations, and they are to be kept on board and made available to the Surveyor on request.

4.5.4 The service life of the harmonic filter is to be declared, and details are to be made available to the Surveyor on request.

4.5.5 Where parallel filter circuits are to be used:
(a) the current imbalance is to be monitored; and
(b) an alarm is to be initiated when the imbalance level could lead to filter failure.

4.5.6 The temperature rating of the harmonic filter is to allow for the increased heating effect of the harmonic distortion, and to be tested during sea trials.

4.5.7 The construction of cabinets for harmonic filters shall be in accordance with the standards for main switchboards, where applicable. *See also Vol 2, Pt 9, Ch 3, 5 Switchgear and controlgear assemblies*.

~~4.5~~ 4.6 Protection of propulsion system

Existing paragraphs 4.5.1 *to* 4.5.10 *have been renumbered* 4.6.1 *to* 4.6.10.

4.6.12 The system integrator is to determine the protection co-ordination required for high voltage propulsion transformers. Where primary protection is to be the only means of protection, evidence demonstrating that this is sufficient is to be submitted for consideration, *see also Vol 2, Pt 9, Ch 4, 4.12 Protection of transfomers 4.12.1*.

~~4.5.11~~ 4.6.13 Alarms and safeguards for electric propulsion equipment are indicated in *Table 5.4.1 Electric propulsion equipment: Alarms and safeguards*.

(*Part only shown*)

Table 5.4.1 Electric propulsion equipment: Alarms and safeguards

Item	Alarm	Note
Electric propulsion generators and motors winding temperature	High	See *Vol 2, Pt 4, Ch 5, 4.1 General 4.1.4* Actions to prevent damage to propulsion motor are to be instigated.
Electric propulsion generator and motor bearing temperature	1st stage high 2nd stage high	*See Vol 2, Pt 4, Ch 5, 4.7 Propulsion motors – general 4.7.5* Safe shutdown to prevent damage. Actions to prevent damage to propulsion motor are to be instigated.
Electric propulsion generator and motor lubricating oil temperature	~~High~~ 1st stage high 2nd stage high	*See Vol 2, Pt 4, Ch 5, 4.7 Propulsion motors – general 4.7.7* and *Vol 2, Pt 9, Ch 2, 6.1 General requirements 6.1.4* Safe shutdown to prevent damage Actions to prevent damage to propulsion motor are to be instigated.

Existing sub-Section 4.6 *has been renumbered* 4.7.

~~4.7~~ 4.8 Propulsion motors – general

Existing paragraphs 4.7.1 *to* 4.7.6 *have been renumbered* 4.8.1 *to* 4.8.6.

~~4.7.7~~ 4.8.7 A high lubricating oil temperature alarm is to be provided for electric propulsion motors that are supplied with forced lubrication, *see also Vol 2, Pt 4, Ch 5, 4.6 Protection of propulsion system 4.6.13* for second stage high temperature shutdown to prevent damage.

Existing sub-Sections 4.8 *to* 4.12 *have been renumbered* 4.9 *to* 4.13.

Volume 2, Part 5, Chapter 1
Torsional Vibration

■ *Section 2*
Documentation required for design review

2.1 Documentation

2.1.4 Details of operating conditions encountered in service for prolonged periods, e.g. idling speed, range of revolutions per minute associated with vessel propulsion at normal speed, combinator characteristics for installations equipped with controllable pitch propellers.

■ *Section 3*
Design

3.1 Symbols and definitions

3.1.4 For a longitudinal slot C_k = 0,3 is applicable within the dimension limitations given in Pt 3, Ch 2,~~*Vol 2, Pt 3, Ch 2, Shafting Systems*~~ *Vol 2, Pt 3, Ch 2, 4.2 Intermediate shafts 4.2.6*. If the slot dimensions are outside these limitations, or if the use of another C_k

is desired, the actual stress concentration factor (*scf*) is to be documented or determined from *Vol 2, Pt 5, Ch 1, 3.1 Symbols and definitions 3.1.5* or by direct application of FE calculation, in which case:

$$C_k = \frac{1,45}{scf}$$

Note that the *scf* is defined as the ratio between the maximum local principal stress and $\sqrt{3}$ times the nominal torsional stress (determined for the bored shaft without slots).

3.1.5 Stress concentration factor of slots. The stress concentration factor (*scf*) at the ends of slots can be determined by means of the following empirical formulae:

$$scf = \alpha_{\mathrm{t(hole)}} + \cancel{0.57}0,8 \frac{\frac{(l - e_h)}{d}}{\sqrt{\left(1 - \frac{d_{\mathrm{i}}}{d}\right)\frac{e_h}{d}}}$$

This formula applies to:

- Slots at 120 or 180 or 360 degrees apart.
- Slots with semicircular ends. A multi-radii slot end can reduce the local stresses, but this is not included in this empirical formula.
- Slots with no edge rounding (except chamfering), as any edge rounding increases the *scf* slightly.

$\alpha_{\mathrm{t(hole)}}$ represents the stress concentration of radial holes and can be determined as:

$$\alpha_{t(hole)} = 2,3 - 3\frac{e_h}{d} + 15\left(\frac{e_h}{d}\right)^2 + 10\left(\frac{e_h}{d}\right)^2\left(\frac{d_i}{d}\right)^2$$

where

e_h = hole diameter, in mm

= or simplified to $\alpha_{\mathrm{t(hole)}} = 2,3$.

3.2 Limiting stress in propulsion shafting

3.2.4 In general, the tensile strength of the steel used is to comply with the requirements of *Vol 2, Pt 3, Ch 2 Shafting Systems*. For the calculation of the permissible limits of stresses due to torsional vibration, σ_u is not to be taken as more than 800 N/mm^2 in the case of alloy steel intermediate shafts or 600 N/mm^2 in the case of carbon and carbon-manganese steel intermediate, thrust and propeller shafts unless, for intermediate shafts only, it is verified that the materials exhibit a similar fatigue life to conventional steels through compliance with the requirements in *Vol 2*, *Pt 3, Ch 2, 6 Approval of alloy steel used for intermediate shaft material*.

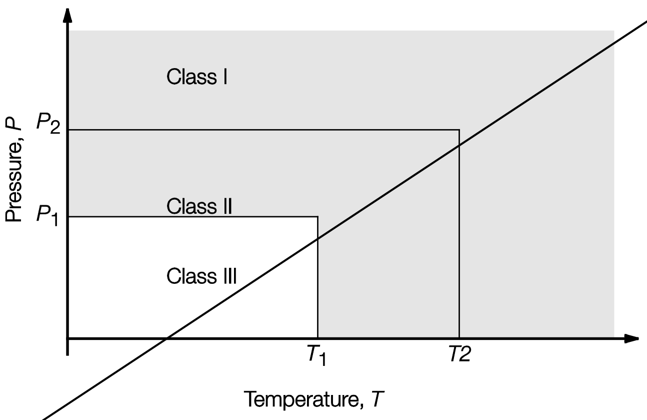
Volume 2, Part 7, Chapter 1
Piping Design Requirements

■ *Section 2* **General**

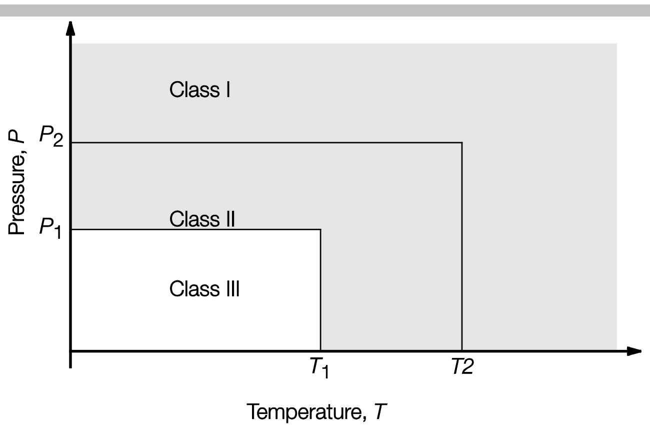
2.3 Classes of piping systems and components

2.3.1 ~~For the purpose of testing the type of joint to be adopted, heat treatment and welding procedure, pipes are subdivided into three classes as indicated in *Table 1.2.1 Classes of piping system*.~~ Pressure piping systems are divided into three classes for the purpose of assigning appropriate testing requirements, types of joints to be adopted, heat treatment and weld procedure.

2.3.2 Dependent on the service for which they are intended, Class II and Class III piping are not to be used for design pressure or temperature conditions in excess of those shown in *Table 1.2.1 Classes of piping system*. Where either the maximum design pressure or temperature exceeds that applicable to Class II piping systems, Class I piping is to be used. To illustrate, *see Figure 1.2.1 Classes of piping system* ~~P_1 and T_1 correspond to maximum pressures and temperatures for a Class III piping system and P_2 and T_2 to those for a Class II piping system depending on the service~~.



~~***Figure 1.3.1 Classes of piping system***~~



NOTE
T_1 and P_1 correspond to the maximum temperatures and pressures for a Class III piping system and T_2 and P_2 to those for a Class II piping system depending on the service.

Figure 1.2.1 Classes of piping system

Table 1.2.1 Classes of piping system

Piping system	Class II		Class III	
	~~p~~ P_2	T_2	~~p~~P_1	T_1
	bar	deg C	bar	deg C
Steam	16,0	300	7,0	170
Thermal oil	16,0	300	7,0	150
Flammable liquids, *see* Note 1	16,0	150	7,0	60
Other media, *see* Note 2	40,0	300	16,0	200

Note *1* Flammable liquids include: fuel oil; lubricating oil and flammable hydraulic oil.
~~**Note** *2* For grey cast iron, *see also* 8.2.2.~~
Note *2* Including water, air, gases, non-flammable hydraulic oil.

2.3.3 In addition to the pressure piping systems in *Table 1.2.1 Classes of piping system*, Class III pipes may be used for open ended piping, e.g. overflows, vents, boiler waste steam pipes, open ended drains, sounding pipes, etc.

2.3.4 Class II and III pipes are not to be used for toxic media.

2.3.5 Class I pipes are generally required for corrosive media. Class II pipes may be used for corrosive media where special safeguards for reducing the potential for leakage and limiting its consequences are provided, e.g. the use of pipe ducts, shielding, screening, etc. in such a way that a leakage will not cause a potential hazard or damage to surrounding areas. Class III pipes are not to be used for corrosive media. Materials used for piping for corrosive media are to be specially considered.

2.3.6 For piping systems or components using cast iron, *see Vol 2, Pt 7, Ch 1, 8 Cast iron piping and components*.

■ *Section 4* **Materials**

4.1 Metallic materials

4.1.2 Materials for ~~Ferrous~~metallic castings and forgings for Class I and II piping systems are to be produced at a works approved by Lloyd's Register (~~hereinafter~~commonly referred to as 'LR') and are to be tested in accordance with the *Rules for the Manufacture, Testing and Certification of Materials* (commonly referred to as the Rules for Materials).

■ *Section 5* **Pipe joints**

5.10 ~~Mechanical connections for piping~~ Other mechanical couplings

5.10.1 Pipe unions, compression couplings, or slip-on joints, as shown in *Figure 1.5.4 Examples of mechanical joints ~~A~~ (Part 1)* and *Figure 1.5.5 Examples of mechanical joints (Part 2)*, may be used if Type Approved for the service conditions and the intended application. The Type Approval is to be based on the results of testing of the actual joints. The acceptable use for each service is indicated in ~~*Vol 2, Pt 7, Ch 1, 5.10 Mechanical connections for piping 5.10.1*~~*Table 1.5.3 Application of mechanical joints* and dependence upon the Class of piping, with limiting pipe dimensions, working pressure and temperature is indicated in *Table 1.5.4 Application of mechanical joints depending on class of piping*.

Figure 1.5.4 Examples of mechanical joints ~~A~~(Part 1) *(Figure not shown, only caption amended)*

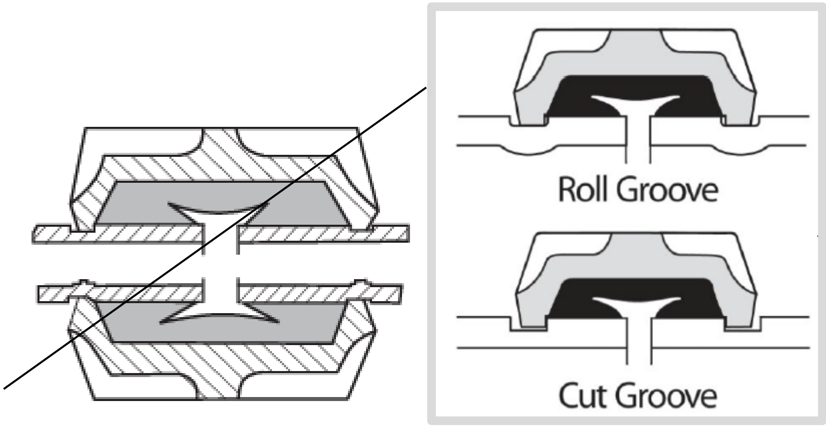
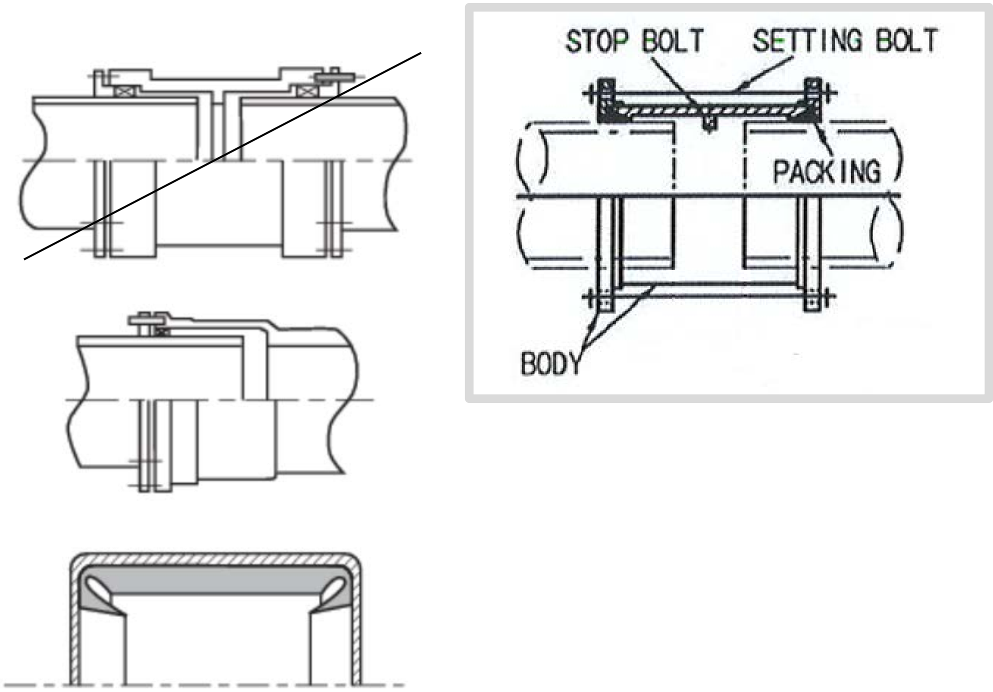
<table>
<tr>
<td>Machine Grooved Type</td>
<td>
</td>
</tr>
<tr>
<td>Slip Type</td>
<td>
</td>
</tr>
</table>

Figure 1.5.5 Examples of mechanical joints ~~B~~(Part 2) *(Part only shown)*

Table 1.5.3 Application of mechanical joints

Systems	~~Kind~~Type of connections		
	Pipe unions	Compression ~~C~~couplings ~~(6)~~	Slip-on joints
Flammable fluids (Flash point <60° C)			
Aircraft and vehicle fuel oil lines *see* Note 4	+	+	+~~5~~
Vent lines *see* Note 3	+	+	+~~3~~
Flammable fluids (Flash point > 60°C)			
Aircraft and vehicle fuel oil lines *see* Note 4	+	+	+
Ship's machinery fuel oil lines *see* Notes 2 & 3	+	+	+~~2,3~~
Lubricating oil lines *see* Notes 2 & 3	+	+	+~~2,3~~
Hydraulic oil *see* Notes 2 & 3	+	+	+~~2,3~~
Thermal oil *see* Notes 2 & 3	+	+	+~~2,3~~
Sea-water			
Bilge lines *see* Note 1	+	+	+~~1~~
HP sea-water and water spray (not permanently filled) *see* Note 3	+	+	+~~3~~
Water filled fire-extinguishing systems, e.g. sprinkler systems *see* Note 3	+	+	+
Non-water filled fire-extinguishing systems, e.g. foam, drencher systems *see* Note 3	+	+	+
~~Foam system~~	~~+~~	~~+~~	~~+3~~
~~Sprinkler system~~	~~+~~	~~+~~	~~+3~~
Ballast system *see* Note 1	+	+	+~~1~~
Cooling water system *see* Note 1	+	+	+~~1~~
Tank cleaning services	+	+	+
Non-essential systems	+	+	+
Fresh water			
Cooling water system *see* Note 1	+	+	+~~1~~
Chilled water systems *see* Note 1	+	+	+~~1~~
Condensate return *see* Note 1	+	+	+~~1~~
Made water and demineralised water system	+	+	+
Ancillary system	+	+	+
Sanitary/Drains/Scuppers			
Deck drains (internal) *see* Note 6	+	+	+~~4~~
Sanitary drains	+	+	+
Scuppers and discharge (overboard)	+	+	-
Sounding/Vent			
Water tanks/Dry spaces	+	+	+
Oil tanks (f.p.> 60°C) *see* Notes 2 & 3	+	+	+~~2,3~~
Intakes and uptakes ~~(8)~~ *see* Note 7			
HVAC trunking ~~(8)~~ *see* Note 7			
Miscellaneous			
High pressure (HP) air systems ~~(1)~~ *see* Note 1	+	+	-
Medium pressure (MP) air systems (Starting air) ~~(1)~~ *see* Note 1	+	+	-
Low pressure (LP) air systems (incl. Control air) ~~(1)~~ *see* Note 1	+	+	-
Service air (non-essential)	+	+	+
Brine	+	+	+
CO_2 system *see* Note 1	+	+	-
Nitrogen system	+	+	-
Steam	+	+	+~~7~~ *see* Note 5

~~Key~~ KEY + Application is allowed - Application is not allowed
Note 1. ~~Inside machinery spaces of category A~~ Mechanical joints that include any components which readily deteriorate in case of fire, are to be of an approved fire-resistant type when fitted in machinery spaces of category A. Mechanical couplings fitted on the 'bilge main' in machinery spaces of category A are to be of steel, CuNi or equivalent material.~~- only approved fire resistant types.~~ **Note** 2. Mechanical joints that include any components which readily deteriorate in case of fire are ~~Not~~ not permitted in~~side~~ machinery spaces of category A or accommodation spaces. Mechanical joints that include any components which readily deteriorate in case of fire that are of an approved fire-resistant type ~~May~~may be ~~accepted~~fitted in other machinery spaces provided the joints are located in easily visible and accessible positions. **Note** 3. ~~Approved fire resistant types~~ Mechanical joints that include any components which readily deteriorate in case of fire are to be of an approved fire-resistant type. ~~Fire resistant type is a type of connection which, when installed in the system and in the event of failure caused by fire, the failure would not result in fire spread, flooding or the loss of a Mobility or Ship Type system.~~ ~~**Note** 4. Above freeboard deck only.~~ **Note** ~~5~~4. Mechanical joints that include any components which readily deteriorate in case of fire are to be of an approved fire-resistant type when fitted ~~In~~in pump rooms and on open decks~~- only approved fire resistant types~~. **Note** ~~7~~5. *See Vol 2, Pt 7, Ch 1, 5.10 Mechanical connections for piping 5.10.~~12~~10*. ~~**Note 6**. If compression couplings include any components which are sensitive to heat, they are to be of approved fire resistant type as required for slip-on joints.~~ **Note** 6. Mechanical joints are only permitted above the limit of watertight integrity. **Note** ~~8~~7. Requirements for HVAC trunking or gas turbine updates and intakes are addressed in the relevant Sections of the Rules.

5.10.2 Where the application of mechanical joints results in a reduction ~~of~~in pipe wall thickness due to the use of bite type rings or other structural elements, this is to be taken into account in determining the minimum wall thickness of the pipe to withstand the design pressure.

~~5.10.3 The construction of mechanical joints is to prevent the possibility of tightness failure affected by pressure pulsation, piping vibration, temperature variation and other similar adverse effects during operation on board.~~

~~5.10.4~~ 5.10.3 ~~The m~~Materials ~~used in the construction~~ of mechanical joints are to be compatible with the piping material and internal ~~/~~ and external media.

~~5.10.5~~ 5.10.4 Mechanical joints for pressure pipes are to be tested to a burst pressure of 4 times the design pressure. For design pressures above 200 bar the required burst pressure will be specially considered.

~~5.10.6 In general, mechanical joints are to be of fire-resistant type where required by *Vol 2, Pt 7, Ch 1, 5.10 Mechanical connections for piping 5.10.1*~~.

~~5.10.8~~ 5.10.5 Mechanical joints, which in the event of damage could cause fire or flooding, are not to be used in piping sections directly connected to the ~~sea openings~~ ship's side below the limit of watertight integrity or tanks containing flammable fluids.

~~5.10.9~~ 5.10.6 The mechanical joints are to be designed to withstand internal and external pressure as applicable and where used in suction lines are to be capable of operating under vacuum.

5.10.7 The number of mechanical joints in flammable fluid systems is to be kept to a minimum. In general, flanged joints are to conform to a recognised standard.

~~5.10.10~~ 5.10.8 Generally, slip-on joints are not to be used in pipelines in cargo holds, tanks, and other spaces which are not easily accessible. Application of these joints inside tanks may only be accepted where the medium conveyed is the same as that in the tanks.

~~5.10.11~~ 5.10.9 ~~Unrestrained slip-on joints are only to be used in cases where compensation of lateral pipe deformation is necessary.~~ Usage of slip type slip-on ~~these~~ joints as the main means of pipe connection is not permitted except for cases where compensation of axial pipe deformation is necessary.

~~5.10.12~~ 5.10.10 Restrained slip-on joints are permitted in steam pipes with a design pressure of 10 bar or less on the weather decks of oil and chemical tankers to accommodate axial pipe movement, *see Vol 2, Pt 7, Ch 2, 2.7 Provision for expansion*.

~~5.10.13~~ 5.10.11 Mechanical joints are to be tested in accordance with the test requirements in LR's Type Approval Test Specification Number 2, as relevant to the service conditions and the intended application. The programme of testing is to be agreed with LR.~~ and is to include the following tests as relevant to the service conditions and the intended application:~~

- ~~leakage test;~~
- ~~vacuum test;~~
- ~~vibration (fatigue) test;~~
- ~~fire endurance test;~~
- ~~burst pressure test;~~
- ~~pressure pulsation test;~~
- ~~reassembly test;~~
- ~~pull-out test;~~
- ~~static displacement/misalignment test~~.

5.11 Additional requirements for mechanical couplings

~~5.10.7~~ 5.11.1 Mechanical pipe connections having sealing components sensitive to heat are not to be used in spaces where leakage or failure caused by fire could result in fire spread, flooding or loss of a Mobility or Ship Type system.

Existing sub-Section 5.11 has been renumbered 5.12

~~5.11~~ 5.12 Piping for gaseous fire-extinguishing systems

~~5.11.3~~ 5.12.3 Materials for the distribution manifolds between the carbon dioxide storage bottles and the discharge valves to each section and associated pipes, valves and fittings of high pressure systems are to be manufactured and tested in accordance with the requirements for Class I piping systems. Pipes are to meet the minimum wall thickness requirements of *Table ~~1.6.4~~ 1.5.5 Minimum thickness for steel pipes for CO_2 fire-extinguishing* and the manifold system is to be hydraulically tested to a pressure of 190 bar. A high pressure system is defined as a system where the carbon dioxide is stored at ambient temperature. Materials for the distribution manifolds between the carbon dioxide storage vessel(s) and the discharge valves to each section and associated pipes, valves and fittings of low pressure systems are to be manufactured and tested in accordance with the requirements for Class II piping systems and the manifold system is to be hydraulically tested to a pressure of 33 bar. A low pressure system is defined as a system where the carbon dioxide is stored at a working pressure in the range of ~~1,8 N/mm² to 2,2 N/mm²~~ 18 bar to 22 bar.

~~5.11.4~~ 5.12.4 Piping downstream of the distribution valve(s) for high pressure systems is to be manufactured and tested in accordance with the requirements for Class II piping and is to meet the minimum wall thickness requirements of *Table ~~1.6.4~~ 1.5.5 Minimum thickness for steel pipes for CO_2 fire-extinguishing*. After installation the distribution system is to be leak tested at a pressure of 6 bar. Piping downstream of the distribution valve(s) for low pressure systems is to be manufactured and tested in accordance with the requirements for Class III piping. After installation the distribution system is to be leak tested at a pressure of 6 bar. Class III piping may be used for open-ended distribution piping downstream of the distribution valve(s) of high pressure systems where agreed by LR and where meeting the minimum wall thickness requirements of *Table ~~1.6.4~~ 1.5.5 Minimum thickness for steel pipes for CO_2 fire-extinguishing* and where a minimum of ten per cent of the piping is hydraulically tested at a pressure of 125 bar. This testing is to be carried out before installation.

Table 1.5.5 Minimum thickness for steel pipes for CO_2 fire-extinguishing

External diameter *D*, in mm	Minimum thickness, in mm	
	From bottles to distribution station	From distribution station to nozzles
21,3 - 26,9	3,2	2,6
30 - 48,3	4	3,2
51 - 60,3	4,5	3,6
63,5 - 76,1	5	3,6
82,5 - 88,9	5,6	4
101,6	6,3	4
108 - 114,3	7,1	4,5
127	8	4,5
133 - 139,7	8	5
152,4 - 168,3	8,8	5,6

Note 1. Pipes are to be galvanized at least inside, except those fitted in the engine room where galvanizing may not be required at the discretion of LR. Effects of galvanising shall be taken into account in the relevant calculations e.g. volume flow.
Note 2. For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread.
Note 3. The external diameters and thicknesses have been selected from ISO Recommendations R336 for smooth welded and seamless steel pipes. Diameter and thickness according to other national or international standards may be accepted.
Note 4. For larger diameters the minimum wall thickness will be subject to special consideration by LR.
Note 5. In general the minimum thickness is the nominal wall thickness and no allowance need be made for negative tolerance or reduction in thickness due to bending.

Volume 2, Part 7, Chapter 2
Ship Piping Systems

■ *Section 10*
Air, overflow and sounding pipes

10.6 Air pipe closing appliances

10.6.1 The closing appliances fitted to tank air pipes in accordance with *Vol 1, Pt 3, Ch 4, ~~7.2 Height of air pipes~~ 7 Air and sounding pipes* are to be of an automatic opening type which will allow the free passage of air or liquid to prevent the tanks being subjected to a pressure or vacuum greater than that for which they are designed, and prevent the free entry of water into the tanks.

10.6.2 Air pipe closing devices are to be type tested in accordance with the test requirements in LR Test Specification Number 2. The flow characteristics of the closing device are to be determined using water. *See ~~Vol 2, Pt 7, Ch 2, 10.8 Overflow pipes 10.8.1~~ Vol 2, Pt 7, Ch 2, 10.7 Size of air pipes 10.7.1* and *Vol 2, Pt 7, Ch 2, 10.7 Size of air pipes 10.7.2*.

10.6.11 The inner and the outer chambers of an automatic air pipe head are to be of a minimum thickness of 6 mm. Where side covers are provided and their function is integral to providing functions of the closing device as outlined in *Vol 2, Pt 7, Ch 2, 10.6 Air pipe closing appliances 10.6.1*, they shall have a minimum wall thickness of 6 mm. If the air pipe head can meet the tightness test in LR's Type Approval Test Specification Number 2 without the side covers attached, then the side covers are not considered to be integral to the closing device, in which case a wall thickness less than 6 mm will be accepted.

10.6.15 Closures and seats made of non-metallic materials are to be compatible with the media intended to be carried in the tank and ~~in~~ with sea-water, and suitable for operating at ambient temperatures between –25°C and 85°C.

Volume 2, Part 9, Chapter 1
General Requirements for the Design and Construction of Electrotechnical Systems

■ *Section 1*
General requirements

1.5 Documentation required for supporting evidence

1.5.8 For optical fibre data communication systems:

(a) details of manufacturer's installation and maintenance recommendations;

(b) data communications network diagram; and

(c) details of the minimum power levels required to maintain the correct operation of the data communications system, which is to include an allowance for the effects of optical fibre degradation due to aging.

■ *Section 2*
System level requirements

2.2 Design, construction and location

2.2.4 Laser light sources for optical fibre systems are to be constructed in accordance with IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*. Acceptance of alternative standards will be subject to consideration by LR.

2.2.5 Optical fibre communication systems are to be constructed in accordance with IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication system*. Acceptance of alternative standards will be subject to consideration by LR.

Existing paragraphs 2.2.4 *to* 2.2.23 *have been renumbered* 2.2.6 *to* 2.2.25*.*

■ *Section 4*
Unattended machinery space(s) – UMS notation

4.6 Fixed water-based local application fire-fighting systems

4.6.1 Where fixed water-based local application fire-fighting systems are installed, they are to satisfy the requirements of *Ch 9,5 Fire safety systems*.

4.6.2 Fixed water-based local application fire-fighting systems are to be capable of automatic release in accordance with FSS Code or an alternative standard defined by the Naval Administration.

Existing sub-Sections 4.6 *and* 4.7 *have been renumbered* 4.7 *and* 4.8.

Volume 2, Part 9, Chapter 2
Electrical Power Generator and Energy Storage

■ *Section 7*
Batteries

7.1 General requirements

7.1.4 The following Sections apply to lead acid and nickel cadmium cell chemistries. Where other cell chemistries are to be used, then a Risk Assessment is to be carried out in accordance with the requirements of *Vol 2, Pt 1, Ch 3, 17 Risk Assessment (RA)*. The Risk Assessment is to include, but is not limited to:

- cell type;
- battery construction;
- the battery management;
- location;
- ventilation requirements;
- installation; and
- fire.

Volume 2, Part 9, Chapter 3
Electrical Power Distribution and Equipment

■ *Section 6*
Rotating machines – general requirements and motors

6.1 General requirements

6.1.2 The insulation system of electrical rotating machines used for Ship Type and Mobility systems are to be tested following the principles detailed in IEC 60505*, Evaluation and qualification of electrical insulations systems*, or an equivalent National Standard acceptable to LR.

Existing paragraphs 6.1.2 *to* 6.1.11 *have been renumbered* 6.1.3 *to* 6.1.12*.*

(*Part only shown*)
~~6.1.10~~ 6.1.11 For high voltage machines, the stator insulation system is to be of a type that has undergone sample testing in accordance with the following International Standards, or relevant alternatives acceptable to LR, to demonstrate its suitability for the operating voltage in the presence of an LR Surveyor:

(a) ~~IEC60894*, Guide for test procedure for the measurement of loss tangent of coils and bars for machine windings*, *at the insulation class rated temperature; and.*~~ IEC 60034-27-3, *Dielectric dissipation factor measurement on stator winding insulation of rotating electrical machines;*

6.7 Survey and testing

6.7.7 The partial discharge characteristics of the rotating machines for Ship Type and Mobility systems are to be measured and recorded in accordance with *Vol 2, Pt 9, Ch 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems*.

■ *Section 7*
Converter equipment

7.2 Semiconductor converters

7.2.5 ~~Liquid cooled converter equipment is to be provided with leakage alarms and there is to be a suitable means provided to contain any liquid which may leak from the system in order to ensure that it does not cause an electrical failure of the equipment. Where the semiconductors and other current carrying parts are in direct contact with the cooling liquid, the liquid is to be monitored for satisfactory resistivity and an alarm initiated at the relevant control station should the resistivity be outside the agreed limits.~~

Liquid cooled converter equipment:
(a) is to be provided with leakage alarms;
(b) is to be provided with a suitable means to contain any liquid which may leak from the system, preventing the liquid from causing further electrical failures or damage; and
(c) where the semiconductors and other current carrying parts are in direct contact with the cooling liquid, they are to be provided with suitable coolant resistivity/conductivity monitoring. Resistivity/conductivity values outside of the agreed limits are to initiate an alarm at the relevant control station; and
(d) if used for main propulsion is to have a suitable safe shutdown to prevent damage to the converter if the cooling liquid exceeds agreed safe limits of resistivity/conductivity. *See also Vol 2, Pt 9, Ch 7, 4.6 Bridge control for main propulsion machinery 4.6.8*.

■ *Section 8*
Electric cables, optical fibre cables and busbar trunking systems (busways)

8.2 Testing

(*Part only shown*)
8.2.1 Routine tests, consisting of at least:
(e) for optical fibres, an attenuation loss (*see* Vol 2, *Part 9, Ch 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems areas*).

8.5 Construction

(*Part only shown*)
8.5.3 Where electric and optical fibre cables are required to be of a `fire resistant type', they are in addition to be easily distinguishable and comply with the performance requirements of the appropriate part of IEC 60331: *Tests for electric cables under fire conditions – Circuit integrity,* when tested with a minimum flame application time of 90 minutes, as follows:

- IEC 60331-1:*Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*;
- IEC 60331-2: *Tests for electric cables under fire conditions – Circuit integrity – Part 2: Test method for fire with shock at a temperature of at least 830 Degrees C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm;*
- IEC 60331-21: *Tests for electric cables under fire conditions – Circuit integrity – Part 21: Procedures and requirements – Cables of rated voltage up to and including 0,6/1,0 kV*~~.~~;
- IEC 60331-23: *Tests for electric cables under fire conditions – Circuit integrity – Part 23: Procedures and requirements – Electric data cables*; or;
- IEC 60331-25: *Tests for electric cables under fire conditions – Circuit integrity – Part 25: Procedures and requirements – Optical fibre cables*.

Table 3.8.2 Maximum rated conductor temperature

Type of insulating compound	Maximum rated conductor temperature, °C		
	Abbreviated designation	Normal operation	Short-circuit
~~**Thermoplastic, based upon:**~~ ~~Vinyl acetate~~		~~70~~	~~150~~
Elastomeric or thermosetting, based upon:			

Ethylene-propylene rubber or similar (EPM or EPDM)	EPR	90	250
High modulus or hard grade ethylene propylene rubber	HEPR	90	250
Cross-linked polyethylene	XLPE	90	250
~~Ethylene-propylene rubber or similar (EPM or EPDM) halogen free~~		~~90~~	~~250~~
~~High modulus or hard grade halogen-free ethylene propylene rubber~~		~~90~~	~~250~~
~~Halogen-free cross-linked polyethylene~~		~~90~~	~~250~~
Cross-linked polyolefin material for halogen-free cables	HF90	90	250
Silicone rubber	S95	95	350
~~Halogen-free silicone rubber~~		~~95~~	~~350~~

Table 3.8.3 Electric cable current ratings, normal operation, based on ambient 45°C

Nominal cross-section (mm^2)	Continuous r.m.s current rating, in amperes								
	~~Thermoplastic (70°C)~~			Elastomeric (90°C)			Elastomeric or thermosetting, based on silicon rubber (95°C)		
	~~Single Core~~	~~2 core~~	~~3 or 4 core~~	Single Core	2 core	3 or 4 core	Single Core	2 core	3 or 4 core
0,75	~~10~~	~~8~~	~~7~~	15	13	11	17	14	12
1	~~12~~	~~10~~	~~8~~	18	15	13	20	17	14
1,25	~~13~~	~~11~~	~~9~~	21	18	14	23	20	16
1,5	~~15~~	~~13~~	~~11~~	23	20	16	26	22	18
2	~~18~~	~~15~~	~~12~~	28	24	19	31	26	22
2,5	~~21~~	~~18~~	~~15~~	30	26	21	32	27	22
3,5	~~26~~	~~22~~	~~18~~	37	32	26	39	33	28
4	~~29~~	~~25~~	~~20~~	40	34	28	43	37	30
5,5	~~35~~	~~30~~	~~24~~	49	42	35	52	44	37
6	~~37~~	~~31~~	~~26~~	52	44	36	55	47	39
8	~~44~~	~~37~~	~~31~~	62	53	44	66	56	46
10	~~51~~	~~43~~	~~36~~	72	61	50	76	65	53
14	~~62~~	~~53~~	~~44~~	88	75	62	94	80	66
16	~~68~~	~~58~~	~~48~~	96	82	67	102	87	71
22	~~83~~	~~70~~	~~58~~	117	100	82	124	106	87
25	~~90~~	~~77~~	~~63~~	127	108	89	135	115	95
30	~~101~~	~~85~~	~~70~~	142	121	100	151	128	106
35	~~111~~	~~94~~	~~78~~	157	133	110	166	141	116
38	~~117~~	~~99~~	~~82~~	165	140	116	175	149	122
50	~~138~~	~~117~~	~~97~~	196	167	137	208	177	146
60	~~155~~	~~132~~	~~109~~	220	187	154	233	198	163
70	~~171~~	~~145~~	~~120~~	242	206	169	256	218	179
80	~~186~~	~~158~~	~~130~~	263	224	184	278	237	195
95	~~207~~	~~176~~	~~145~~	293	249	205	310	264	217
100	~~213~~	~~181~~	~~149~~	302	257	212	320	272	224
120	~~239~~	~~203~~	~~167~~	339	288	237	359	305	251
125	~~245~~	~~209~~	~~172~~	348	295	243	368	313	258
150	~~275~~	~~234~~	~~193~~	389	331	272	412	350	288
185	~~313~~	~~266~~	~~219~~	444	377	311	470	400	329
200	~~329~~	~~280~~	~~230~~	466	396	326	494	420	346
240	~~369~~	~~314~~	~~258~~	522	444	365	553	470	387
300	~~424~~	~~360~~	~~297~~	601	511	421	636	541	445

Table 3.8.4 Electric cable current ratings, r.m.s. short circuit current

Nominal cross section (mm²)	~~Fault current (kA) at 150°C~~			Fault current (kA) at 250°C			Fault current (kA) at 350°C		
	~~1 s duration~~	~~0,5 s duration~~	~~0,1 s duration~~	1 s duration	0,5 s duration	0,1 s duration	1 s duration	0,5 s duration	0,1 s duration
0,75	~~0,1~~	~~0,1~~	~~0,3~~	0,1	0,2	0,3	0,1	0,2	0,4
1	~~0,1~~	~~0,2~~	~~0,3~~	0,1	0,2	0,5	0,2	0,2	0,5
1,25	~~0,1~~	~~0,2~~	~~0,4~~	0,2	0,3	0,6	0,2	0,3	0,7
1,5	~~0,2~~	~~0,2~~	~~0,5~~	0,2	0,3	0,7	0,3	0,4	0,8
2	~~0,2~~	~~0,3~~	~~0,7~~	0,3	0,4	0,9	0,3	0,5	1,1
2,5	~~0,3~~	~~0,4~~	~~0,9~~	0,4	0,5	1,1	0,4	0,6	1,4
3,5	~~0,4~~	~~0,5~~	~~1,2~~	0,5	0,7	1,6	0,6	0,8	1,9
4	~~0,4~~	~~0,6~~	~~1,4~~	0,6	0,8	1,8	0,7	1,0	2,2
5,5	~~0,6~~	~~0,8~~	~~1,9~~	0,8	1,1	2,5	0,9	1,3	3,0
6	~~0,7~~	~~0,9~~	~~2,1~~	0,9	1,2	2,7	1,0	1,5	3,2
8	~~0,9~~	~~1,2~~	~~2,8~~	1,1	1,6	3,6	1,4	1,9	4,3
10	~~1,1~~	~~1,5~~	~~3,5~~	1,4	2,0	4,5	1,7	2,4	5,4
14	~~1,5~~	~~2,2~~	~~4,8~~	2,0	2,8	6,3	2,4	3,4	7,6
16	~~1,7~~	~~2,5~~	~~5,5~~	2,3	3,2	7,2	2,7	3,9	8,7
22	~~2,4~~	~~3,4~~	~~7,6~~	3,1	4,5	10,0	3,8	5,3	11,9
25	~~2,7~~	~~3,9~~	~~8,6~~	3,6	5,1	11,3	4,3	6,0	13,5
30	~~3,3~~	~~4,6~~	~~10,4~~	4,3	6,1	13,6	5,1	7,3	16,2
35	~~3,8~~	~~5,4~~	~~12,1~~	5,0	7,1	15,8	6,0	8,5	18,9
38	~~4,1~~	~~5,9~~	~~13,1~~	5,4	7,7	17,2	6,5	9,2	20,6
50	~~5,5~~	~~7,7~~	~~17,3~~	7,2	10,1	22,6	8,6	12,1	27,1
60	~~6,5~~	~~9,3~~	~~20,7~~	8,6	12,1	27,1	10,3	14,5	32,5
70	~~7,6~~	~~10,8~~	~~24,2~~	10,0	14,2	31,7	12,0	16,9	37,9
80	~~8,7~~	~~12,3~~	~~37,6~~	11,4	16,2	36,2	13,7	19,4	43,3
95	~~10,4~~	~~14,7~~	~~32,8~~	13,6	19,2	43,0	16,3	23,0	51,4
100	~~10,9~~	~~15,4~~	~~34,5~~	14,3	20,2	45,2	17,1	24,2	54,1
120	~~13,1~~	~~18,5~~	~~41,4~~	17,2	24,3	54,3	20,5	29,0	64,9
125	~~13,6~~	~~19,3~~	~~43,1~~	17,9	25,3	56,6	21,4	30,2	67,6
150	~~16,4~~	~~23,2~~	~~51,8~~	21,5	30,4	67,9	25,7	36,3	81,2
185	~~20,2~~	~~28,6~~	~~63,9~~	26,5	37,4	83,7	31,7	44,8	100,1
200	~~21,8~~	~~30,9~~	~~69,0~~	28,6	40,5	90,5	34,2	48,4	108,2
240	~~26,2~~	~~37,0~~	~~82,8~~	34,3	48,6	108,6	41,1	58,1	129,9
300	~~32,7~~	~~46,3~~	~~103,6~~	42,9	60,7	135,7	51,3	72,6	162,3

Table 3.8.5 Correction factors

Insulation material	Correction factor for ambient air temperature of °C										
	35	40	45	50	55	60	65	70	75	80	85
~~Thermoplastic (70°C)~~	~~1,18~~	~~1,10~~	~~1,00~~	~~0,89~~	~~0,77~~	~~0,63~~	—	—	—	—	—
Elastomeric or thermosetting (90°C)	1,10	1,05	1,00	0,94	0,88	0,82	0,74	0,67	0,58	0,47	—
Elastomeric or thermosetting, based on silicone rubber (95°C)	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0,55	0,45

8.8 Installation of electric and optical fibre cables

8.8.3 The manufacturer's tensile load limit of the optical fibre is not to be exceeded during installation.

8.8.4 The manufacturer's minimum bend radii for optical fibres is not to be exceeded during installation.

8.8.5 Pre- and post-installation tests are to be conducted on optical fibre cables as detailed in *Vol 2, Part 9, Ch 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems areas*.

Existing paragraphs 8.8.3 *to* 8.8.22 *have been renumbered* 8.8.6 *to* 8.8.25.

Table 3.8.6 Minimum internal radii of bends in cables for fixed wiring

Cable construction		Overall diameter of cable	Minimum internal radius of bend (times overall diameter of cable)
Insulation	Outer covering		
~~Thermoplastic and e~~Elastomeric 600/1000 V and below	Metal sheathed Armoured and braided	Any	6*D*
	Other finishes	≤ 25 mm > 25 mm	4*D* 6*D*
Mineral	Hard metal sheathed	Any	6*D*
~~Thermoplastic and e~~Elastomeric above 600/1000 V – single core	Any	Any	12*D*
– multicore	Any	Any	9*D*

Volume 2, Part 9, Chapter 4
Electrical Protection

■ *Section 4*
System design - protection

4.13 Harmonic filters

4.13.3 Where parallel harmonic filters are used:
(a) an alarm is to be initiated in the event of current imbalance that could lead to failure of a harmonic filter;
(b) current imbalance circuits are to fail safe; and
(c) the restarting of harmonic filters is to require manual intervention.

Volume 2, Part 9, Chapter 5
Hazardous Areas

■ *Section 4*
Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

4.2 Selection of equipment for use in explosive gas atmospheres

4.2.9 Where optical fibre transmission equipment located in a hazardous or non-hazardous area provides energy to, or passes optical energy through, a hazardous area with an explosive gas atmosphere, then:
(a) the protection type to be appropriate to the zone classification, as detailed in *Table 5.4.1 Zone classification for types of protection associated with optical fibre transmission systems*.
(b) the optical energy levels in zone 0 and 1, including fault conditions, are to be limited to 5mW/mm^2 or 35mW for constant wave and 0,1mj/mm^2 pulsed.
(c) the optical energy levels in zone 2, including fault conditions, are to be limited to 10mW/mm^2 or 35mW for constant wave and 0,5mj/mm^2 pulsed; and
(d) pulsed sources with a pulse interval less than 5 seconds, are to be considered constant wave sources.

Table 5.4.1 Zone classification for types of protection associated with optical fibre transmission systems

Zone	Type of protection allowed	Associated requirements
0	'op is', Inherently safe optical radiation,	Safe with two faults
	'op sh', Protected fibre optic media with ignition capable beam	additional mechanical protection required
1	'op is', Inherently safe optical, radiation	Safe with single fault
	'op pr', Protected fibre optic media with ignition capable beam	with additional mechanical protection required
	'op sh', Protected fibre optic media with ignition capable beam interlocked with fibre breakage	additional mechanical protection not necessarily required
2	'op pr', inherently safe optical radiation, 'op is'	Safe in normal operation
	'op pr', Protected fibre optic media with ignition capable beam	additional mechanical protection not necessarily required
	'op sh', Protected fibre optic media with ignition capable beam interlocked with fibre breakage	additional mechanical protection not necessarily required

4.3 Selection of equipment for use in the presence of combustible dusts

4.3.2 Where optical fibre transmission equipment located in a hazardous area, extended hazardous area or non-hazardous area provides energy to, or passes optical energy through, a hazardous area with combustible dusts, then the optical energy levels are to be:

(a) restricted in hazardous area to 5mW/mm^2 or 35mW maximum for constant wave sources or 0,1mj/mm^2 for pulsed sources;

(b) restricted in extended hazardous area to 10mW/mm^2 or 35mW maximum, for constant wave sources or 0,5mj/mm^2 for pulsed sources.

(c) where pulsed source has a pulse interval less than 5 seconds, it is to be considered constant wave source.

Existing paragraphs 4.3.2 to 4.3.5 have been renumbered 4.3.3 to 4.3.6.

Volume 2, Part 9, Chapter 6
Lighting

■ *Section 4*
Lighting systems

4.4 Emergency lighting

4.4.4 The exit(s) from every main compartment occupied by crew and embarked personnel is to be continuously illuminated by an emergency lighting fitting. These are to include, but are not limited to:

- Accommodation spaces such as corridors, heads and bathrooms, cabins, offices, mess decks, hospitals, pantries containing no cooking appliances, and similar spaces;
- Service spaces such as spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, storerooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

4.4.5 The requirements of *Vol 2, Pt 9, Ch 6, 4.4 Emergency lighting 4.4.4* are subject to the darken ship requirements of the Naval Administration.

Existing paragraphs 4.4.5 to 4.4.8 *have been renumbered* 4.4.6 *to* 4.4.9.

Volume 2, Part 9, Chapter 11
Testing and Trials

■ *Section 1*
Testing and trials

1.2 Trials

1.2.5 The insulation resistance is to be measured of all electrical power circuits and electrical equipment, using a direct current insulation tester, between:
(a) all current carrying parts connected together and earth and, so far as is reasonably practicable;
(b) all current carrying parts of different polarity or phase.
The minimum values of test voltage and insulation resistance are given in *Table 11.1.2 Test voltage and minimum insulation*. The installation may be subdivided and appliances may be disconnected if initial tests produce results less than these figures.

(Part only shown)
1.2.7 It is to be demonstrated that the Rules have been complied with in respect of:
(i) propulsion equipment is to be tested under working conditions and operated in the presence of the Surveyors and to their satisfaction. The equipment is to have sufficient power for going astern to secure proper control of the ship in all normal circumstances. The ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, under normal manoeuvring conditions, and so bring the ship to rest from maximum ahead service speed, is to be demonstrated at the sea trial, *see also Vol 2, Pt 1, Ch 3, 16.3 Performance testing 16.3.7*;
(j) the operation of the propulsion system with the harmonic filter removed from circuit is to be verified in accordance with the design intent, *see Pt 4, Ch 5,4.5 Protection of propulsion system 4.5.4.* Any operational and functional limitations are to be documented and details retained on board; and
~~(j)~~(k) operation of power management for electric propulsion.

1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems

1.4.1 To enable future trend analysis, on completion of harbour acceptance trials or during sea acceptance trials, partial discharge measurements are to be conducted which will baseline the partial discharge characteristics of the rotating machine. A copy of the test report is to be retained on board and made available to the Surveyor on request.

1.4.2 At the first Annual Survey, or within 3 months of the due date, the partial discharge measurements required by *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.1* are to be repeated. A copy of the test report is to be retained on board and made available to the Surveyor on request.

1.4.3 At Complete Survey or, within 3 months of the due date, the partial discharge measurements required by *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.1* are to be repeated. A copy of the test report is to be retained on board and made available to the Surveyor on request.

1.4.4 The partial discharge measurement method to be used is to be acceptable to the rotating machine manufacturer. Particular attention is to be given to ensuring:
(a) the test voltage and frequency (i.e. ac, dc or ultra-low frequency and voltage level), and method selected are to be compatible with the insulation systems; and
(b) the tests do not over stress or cause accelerated aging of the insulation system.

1.4.5 The measurements required by *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.1* to *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.3* are to be conducted and recorded in accordance with one of the following standards as appropriate to the design and application of the rotating machine:
- IEC TS 60034-27, *Rotating electrical machines – Part 27: Off-line partial discharge measurements on the stator winding insulation of rotating electrical machine;*
- PD IEC/TS 60034-27-2:2012, *Rotating electrical machines – Part 27-2: On-line partial discharge measurements on the stator winding insulation of rotating electrical machines*;
- DD IEC/TS 61934:2011, *Electrical insulating materials and systems – Electrical measurement of partial discharges (PD) under short rise time and repetitive voltage impulses*; or
- an alternative relevant National Standard acceptable to LR.

1.4.6 The test report required by *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship Type and mobility systems 1.4.1* to *Vol 2, Pt 9, Chapter 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.3* is to record the method and equipment used in sufficient detail to ensure the tests can be repeated consistently throughout the service life of the rotating machine.

1.4.7 The test report required by *Vol 2, Pt 9, Ch 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.6* is to include, but not be limited to, the details recommended by the test standard to be applied (*see Vol 2, Pt 9, Ch 11,1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility mystems 1.4.5*).

1.4.8 The documentation required by *Vol 2, Pt 9, Ch 11, 1.4 Partial discharge testing of high voltage rotating machines for ship type and mobility systems 1.4.6* is to be provided to the end user as part of the as-built documentation for the rotating machine.

1.4.9 Partial discharge measurements are to evaluated by suitably qualified and experienced personnel, and are to remain within the manufacturers' recommendations.

1.4.10 Where partial discharge measurements exceed the manufacturer's recommendations corrective action is to be taken.

1.4.11 Where on line partial discharge monitoring equipment is installed, which is capable of being used to alert the ship's staff of an increase in partial discharge activity, the output is to be included as an alert, with alert levels set and the actions required to be specified by the manufacturer of the rotating machine.

1.5 Optical Fibre Communications Systems

1.5.1 The attenuation loss of single mode optical fibre is to be tested prior to installation in accordance with IEC 61280: *Fibre-optic communication subsystem test procedures Part 4-2: Installed cable plant – Single-mode attenuation and optical return loss measurement*. The test is to be recorded in accordance with the standard. The documentation is to be retained on board and made available to the Surveyor on request. Acceptance of alternative standards will be subject to consideration by LR.

1.5.2 The attenuation loss of multimode optical fibre is to be tested prior to installation in accordance with IEC 61280: *Fibre optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement*. The test is to be recorded in accordance with the standard. The documentation is to be retained on board and made available to the Surveyor on request. Acceptance of alternative standards will be subject to consideration by LR.

1.5.3 The tests required by *Pt 9, Ch 11, 1 Testing and trials 1.4.1* and *Pt 9, Ch 11, 1 Testing and trials 1.4.2* are to be repeated after installation using the same method as used for the pre-installation test. The test is to be recorded in accordance with the standard; the documentation is to be retained on board and made available to the Surveyor on request. Acceptance of alternative standards will be subject to consideration by LR.

1.5.4 The results of the testing required by *Pt 9, Ch 11, 1 Testing and trials 1.4.3* are to be validated against the communication system design specification to ensure that adequate optical power will be transmitted for correct system operation (*see Vol 2, Pt 9, Ch 1, 1.5 Documentation required for supporting evidence 1.5.8*).

Existing sub-Sections 1.4 *to* 1.8 *have been renumbered* 1.6 *to* 1.10.

Volume 2, Part 11, Chapter 1
Made and Fresh Water Systems

■ *Section 3*
System arrangements

3.1 Water storage facilities

3.1.3 The internal structure of fresh water tanks is to be designed to ensure efficient drainage to the suction point. ~~Fresh water tanks are not to have a common boundary with another tank that can contain oil or any other liquid except fresh water ballast.~~ Access arrangements to storage tanks are to be arranged and sited clear of sources of possible contamination, *see also Vol 1, Pt 3, Ch 2, 4.9 Separation and protection of tanks*.

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